Secular Trend in Body Height and Weight of Australian Children and Adolescents

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KEY WORDS secular increase; stature; weight; schoolchildren

ABSTRACT Secular changes in growth and maturation have been well documented in various world populations, with secular increase especially noticeable in the developed countries. To assess the trend in both adult size and tempo of growth we compared the data on stature and body weight obtained in 1992–1993 from 1,804 Melbourne school students aged 5 to17 with historical data collected from white Australians during the last 100 years. We illustrate the age-dependent trend in stature and body weight by means of regression surfaces. These were constructed by fitting local regression models to historical data and by simple plots showing the overall, and per decade, secular increase in both these measures at peripubertal and adult ages. Because of limited information on sample sizes and variability provided by the historical data, statistical comparisons have been performed only between the present 1992–1993 survey and two earlier independent surveys conducted in 1985 and 1970. The results have shown secular increase in adult stature over the last century, with the rate of increase varying between 0.4 and 2.1 cm/decade in males and 0.01 and 1.6 cm/decade in females. While secular increase in stature has significantly slowed down during the last two decades, the increase in body weight is still continuing at a high rate, and this increase is more pronounced in females. The period of strong secular increase, especially in the tempo of growth, coincided both with the shift toward earlier menarche and the improvement of socioeconomic conditions of the Australian population. The need for further studies to identify factors determining the continuing increase in body weight is emphasized, and caution in using the existing national growth standards for stature and weight is recommended. Am J Phys Anthropol 111:545–556, 2000.

The secular trend in growth and maturation over the last two centuries has been demonstrated in a large number of diverse human populations. Secular changes are best documented for body height and weight, and weight-for-height (reviewed in Roche 1979; Himes 1979; Eveleth and Tanner, 1990; Galuska et al., 1996; Hauspie et al., 1997), as historical data on these measures have been readily available.

Although the mechanisms underlying secular trend in growth measures are not fully understood, environmental factors are believed to constitute a major cause of secular increase (Malina, 1979; Taranger, 1983; Susanne, 1985; van Wieringen, 1986; Tanner, 1992). The studies worldwide have indeed demonstrated a sensitivity of secular trend to changes in life standards both over time and

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Received 30 December 1998; accepted 10 October 1999.

between different social groups (reviewed in Malina, 1979; Hauspie et al., 1997). Secular increase in growth have thus been regarded as indicators of the improvement of socio-economic and socio-hygienic conditions, and of a population's state of health (van Wieringen, 1986). However, changing levels of well-being in a society cannot fully explain secular trend which, in some populations, has failed to continue, or to occur at all, in spite of continuing improvement of life standards and health (e.g., Ducros, 1980; Henneberg and van den Berg, 1990; Hauspie et al., 1997; Henneberg, 1997; Pretty et al., 1998; Tracer et al., 1998). Genetic factors clearly play a role in restraining, rather than enhancing, secular trend by imposing limits on the extent of increase in body size. Recent results of analysis of longitudinal twin data have indeed demonstrated the major effect of a genetic component in growth down-regulation, by showing that the surge of genetic variance in both stature and skeletal maturity coincides with the stage of rapid slowing down in growth rate (Loesch et al., 1995).

The aim of this study is to review age-dependent secular changes in body height and weight in white Australians, from the beginning of this century to the most recent anthropometric survey conducted in Melbourne schools (Hill et al., 1997; Loesch and Huggins, 1998). A secular trend in both these measures from the 1895–1902 studies in Victoria (Powys, 1901–1902), Tasmania (Bjelke-Petersen, 1902) and New South Wales (Coghlan, 1902), through to our own 1992–1995 study is illustrated, and the results of the present study are statistically compared with the more recent historical data. Unlike most earlier studies, changes in children/adolescents, as well as in 17-year-old students of either sex, have been considered. The results of comparison are interpreted in relation to changes in socio-economic conditions and demographic structure of the Australian population which took place during the last century.

DATA AND METHODS

Present sample

The data on body height and weight were collected from 1,804 white Australian students aged 5 to 17 years attending primary and secondary schools in metropolitan Melbourne, who participated in the first (1992–1993) round of a large mixed longitudinal growth study (Loesch and Huggins, 1998). The sampling procedure was as described in Hill et al. (1997) and Loesch and Huggins (1998). Random samples of 35 children from each of the 50 preselected schools were drawn to ensure that each child in the population of Melbourne schoolchildren would have a nearly equal probability of being included in the sample. Approximately 5% of the initially drawn subjects were of Asian origin, and they were omitted from the analysis, so that only the data from children with both parents of European (mostly Northern) descent remained in the study. The sample of schools was drawn to represent the distribution of Ross Index of socio-economic status (Ross, 1984; Ross et al., 1988) among Melbourne schoolchildren. Thus, 59% of selected students were in the highest, 16% in the middle, and 25%, in the lowest socioeconomic category.

Stature and weight were measured by the same researcher, and each child was measured in light clothing and without shoes. Weight was recorded to the nearest half kilogram. Height was recorded using a free standing Martin Saller type of anthropometer and measured to the nearest millimeter. Samples of both primary and secondary schoolchildren from various strata were tested throughout the whole year to counteract the effect of any seasonal variation in body measures.

Historical data

The sources of data on mean values of stature and/or weight in individual age groups included in this study are listed in Table 1. The earlier data on stature collected in the 19th century from male convicts transported from Britain to Australia were not included because of the specific nature of these samples, and a controversy concerning the extremely low stature of the subjects (Gandevia, 1977; Nicholas and Shergold, 1988). Moreover, historical data based on age categories different from those in our 1992–1993 study were omitted from data presentation and analysis. All surveys

TABLE 1. List of historical survey data included in this study

No.	Year(s)	Sample	Source of data
1	1893–1895	Victorian (VIC) males and females aged 15 yr and over N = 60,850	Powys (1901–1902)
2	1901	Tasmanian (TAS) boys aged 8–15 yr N = 500	Bjelke-Petersen (1902)
3	1901	New South Wales (NSW) schoolchildren aged 5.5–16.5 yr N = 2,000	Coghlan (1902)
4	1908	New South Wales (NSW) schoolchildren aged 3–20 yrs N = 36,850	Roth and Harris (1908)
5	1911	Queensland (QLD) schoolchildren aged 7–14 yr N = 3,000	Bourne (1911)
6	1911–1912	Victorian (VIC) schoolchildren aged 4–14 yrs N = 11,464	Sutton and VGSO[1] (1911–1912)
7	1913–1914	Victorian (VIC) schoolchildren aged 12–18 yr N = 1,638	Sutton and VGSO (1913–1914)
8	1914–1915	Victorian (VIC) schoolchildren aged 5–13 yr N = 2,991	Sutton et al. (1914–1915)
9	1912	Commonwealth military male cadets aged 11.5–18 yr and over N = 120,702	ANZAAS (1933, pp. 484–485)
10	1922	Victorian (VIC) schoolchildren aged 4–18 yr N = 26,527	Greig and VGSO (1924–1925)
11	1937	New South Wales (NSW) schoolchildren aged 5.5–15.5 yr N = 50,000	Machin (1939)
12	1950	Queensland (QLD) schoolchildren aged 5–13 yr N = 10,233	Patrick (1951)
13	1952	Victorian (VIC) schoolchildren aged 5.5–15.5 yrs N[2]	Lane (1952) cited in Meyers (1956, p. 453, Table 24)
14	1954	New South Wales (NSW) schoolchildren aged 4–18 yr N = 19,607	Meyers (1956)
15	1970–1971	New South Wales (NSW) schoolchildren aged 5–19 yr N = 12,000	Jones et al. (1973)
16	1985	Australian (AUS) schoolchildren aged 7–15 yr N = 8,500	ACHPER[3] (1985)
17	1992–1993	Victorian (VIC) schoolchildren aged 5–18 yr N = 1,804	Present sample: Loesch and Huggins (1998)

[1]VGSO, Victorian Government Statistics office.
[2]Historical data on sample size not available.
[3]ACHPER, Australian Council for Health, Physical Education and Recreation.

from Western Australia were also excluded. With its great physical distance and isolation from the eastern states, there was potentially different demographic and socioeconomic structure.

Data analysis

There have been the usual difficulties in analyzing and interpretation of historical data because most studies record only trait means and sample sizes, while the information either on methods of collecting the measurements or accuracy of assessments are usually not available. Therefore, the results should be seen as a guide to change rather than a quantitative estimate, and comparisons with the majority of historical data included in this study are limited to fitting local regression models to trait means. To do this, the differences between the age specific average stature from the VIC1992 survey, and those from the individual historical surveys, were modeled. This model was a function of the age and the number of years between 1992 and the year that each survey was conducted. These surveys ranged from 7 years before 1992 (AUS1985), to 91 years before 1992 (TAS1901). As sample sizes and/or standard deviations were unavailable for most of the early series, each mean was given

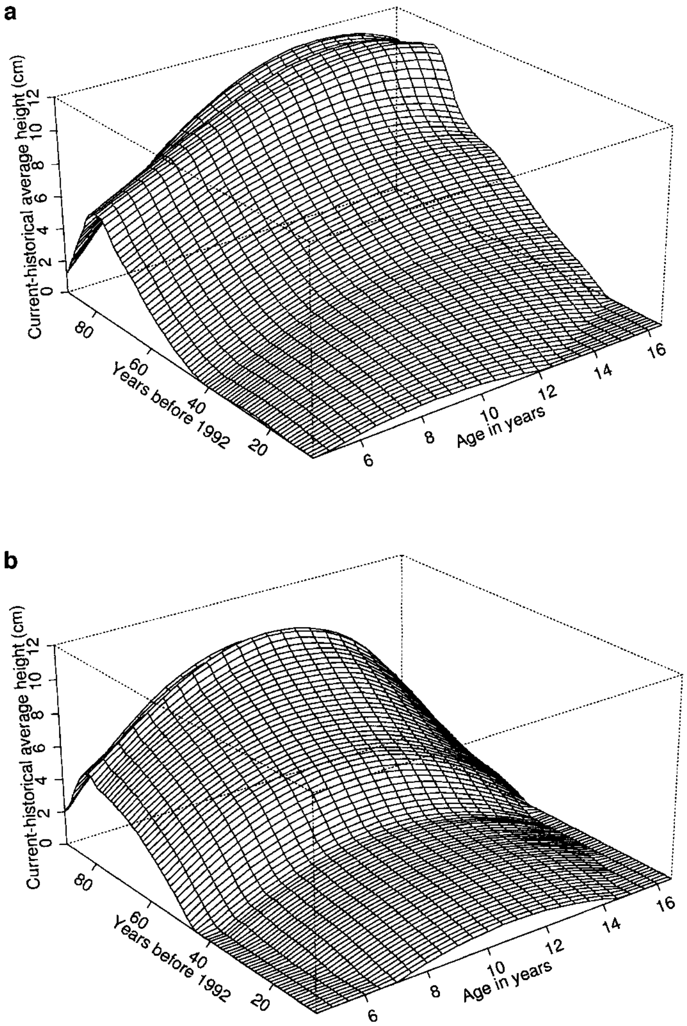

Fig. 1. Three-dimensional regression surface plots representing differences between current and historical average stature (in cm) for males **(a)** and females **(b)**.

an equal weight. The model was fitted using the loess function (Cleveland et al., 1993) in the Splus statistical computing package (Becker et al., 1988). The fitted model was a local quadratic in age and years; to concentrate on the general trend in the data over time and for consistency across traits and sexes, the smoothing constant was taken as 0.5 in all model fits. This smoothing procedure filled in the gaps between the various surveys, making the long-term secular trend easier to distinguish. The function is presented in Figures 1 and 2 as three-dimensional plots of the modeled differences in average stature at each age, against the age and the time distance in years. In addition, the trend in stature and weight across several historical periods has been illustrated by simple plots (Figs. 3 and 4), where the increase/decade has been estimated by dividing the difference between the means for stature (in cm) or in weight (in kg) from the two respective surveys ($\times$ 10), by the number of years between those surveys.

Standard statistical comparisons of age-specific means for stature and weight were performed only between the present study and the data from two earlier studies, NSW1970 and AUS1985 (listed in Table 1), where the information on all summary statistics, as well as on data collection method-

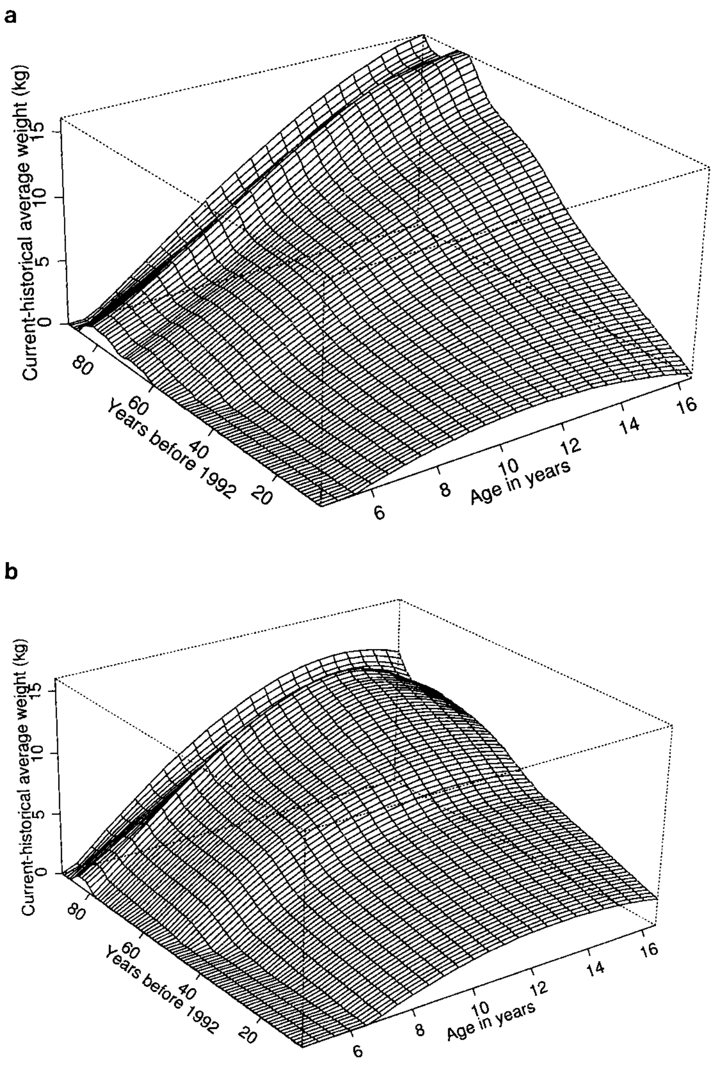

Fig. 2. Three-dimensional regression surface plots representing differences between current and historical average weight (in kg) for males **(a)** and females **(b)**.

ology and accuracy of the measurements, were available; both their methods and accuracy were consistent with those in our study. The significance of differences between the means (in Tables 2 and 3) was assessed by the *t*-test, using the SPSS package (Norusis et al., 1993).

The relative effect of socioeconomic status (SES) on growth was examined cross-sectionally in our VIC1992 survey data using polynomial regression models. A generalized linear model with independent variables: sex (two-levels), SES status (three-levels), and a fourth-order polynomial in age was fitted to weight and stature using the statistical computing package GLIM (Payne, 1985). In order to determine if SES affected either stature or weight, a baseline model allowing different fourth-order polynomials in age for each sex was initially fitted. This was followed by a more complex model, which allowed different fourth-order polynomials for each sex and SES category. The significance of the effect of the SES class on the mean curve was then determined using the standard F tests. This was done for both weight and stature and, if SES effect was significant for sexes combined, this effect was then tested separately for males and females.

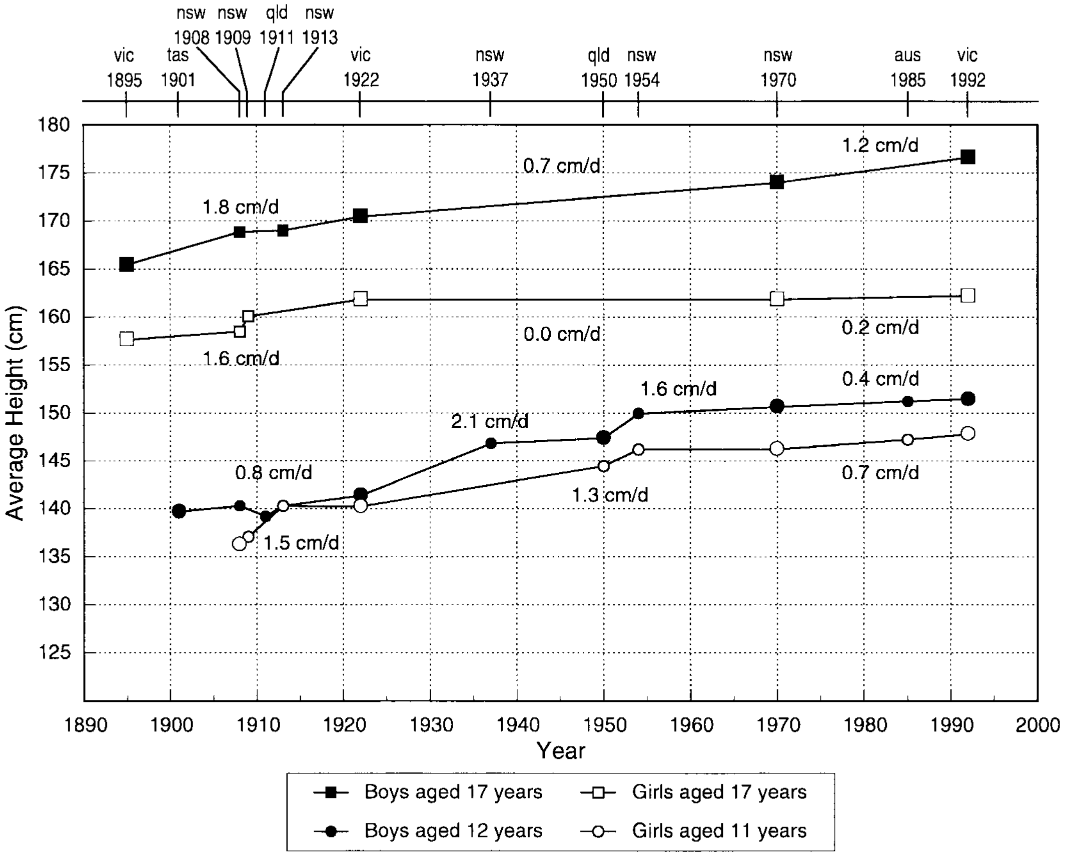

Fig. 3. Secular change in male and female stature between 1985 and 1992. Secular increase (cm/decade) was estimated between NSW1895, VIC1922, NSW1970, and VIC1992 surveys, for adult subjects; and between TAS 1901, VIC1922, QLD1950, NSW1970, and VIC1992 surveys, for peripubertal males; and between NSW1908, VIC1922, NSW1970, and VIC1992 surveys, for females.

RESULTS

Overall trend-regression surfaces

The overall trend in stature throughout this century is illustrated by the local regression surfaces plotted for males (Fig. 1a) and females (Fig. 1b). The plots indicate that 80 years ago both males and females were considerably shorter than today, with the greatest differences being for 14-year-old boys and 12-year-old girls. Thus the largest gains in stature have been, in either sex, around the respective pubertal ages and the smallest at reaching adult height. Mean stature increased steadily between 80 and 40 years ago, with a lesser increase in the last four decades. The regression surfaces for weight for males and females are plotted in Figure 2a and b, respectively. The changes in weight over time are generally similar to those in stature, except that the increase in weight still continues in both sexes.

Specific features of secular trend

Secular trend in stature of 17-year-old students ("adults") compared with this trend for 12-years-old boys and 11- year-old girls between the years 1895 and 1992 is illustrated in Figure 3. The data show steady increase in male adult stature during the period covered by these surveys, with the largest increase between 1922 and 1985 Victorian surveys. While the largest increase in female adult stature took place

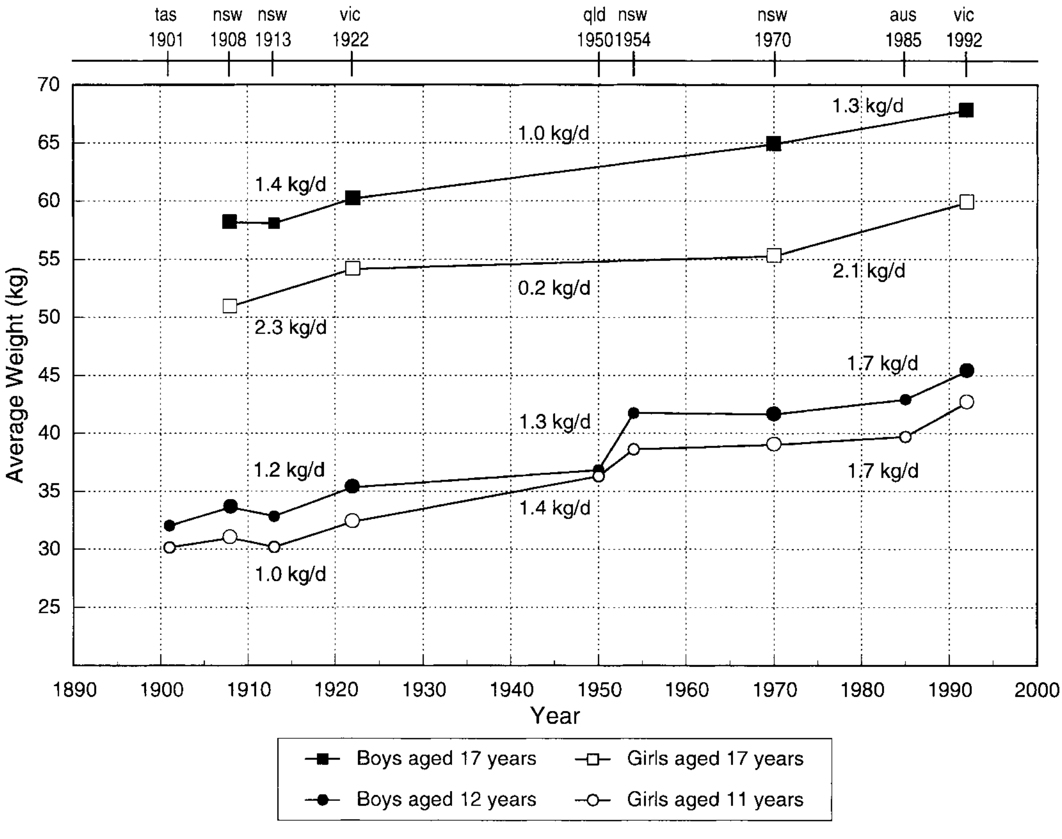

Fig. 4. Secular change in male and female weight between 1901 and 1992. Secular increase (cm/decade) was estimated between NSW1908, VIC1922, NSW1970, AUS1985, and VIC1992 surveys, for adults subjects; and between NSW1908, VIC1922, NSW1970, and VIC1992 surveys, for peripubertal males and females.

TABLE 2. Summary statistics and results of comparison of mean stature at ages 10–13 yr and 16–17 yr betweenthe present "VIC 1992" sample, and "AUS 1985" and "NSW 1970" samples of males (M) and females (F)[1]

Age in yrs	Sex	VIC 1992 N	VIC 1992 M	VIC 1992 SD	AUS 1985 N	AUS 1985 M	AUS 1985 SD	NSW 1970 N	NSW 1970 M	NSW 1970 SD	Difference (P) VIC 1992 AUS 1985	Difference (P) VIC 1992 NSW 1970
10	M	59	142.4	6.5	492	140.7	6.0	813	139.3	6.4	0.020	0.000
	F	77	142.4	7.3	497	140.7	6.5	637	138.9	6.9	0.020	0.000
11	M	46	145.6	7.1	487	146.0	7.1	808	144.5	6.9	0.656	0.149
	F	100	147.8	7.5	484	147.2	7.6	688	146.2	7.8	0.243	0.028
12	M	53	151.2	8.8	494	151.2	7.8	1411	150.6	7.6	0.507	0.294
	F	83	154.3	7.6	489	153.0	7.0	1533	151.7	7.3	0.064	0.001
13	M	69	159.7	8.0	466	158.9	8.7	1322	156.5	8.3	0.230	0.001
	F	83	157.6	6.3	437	157.7	6.8	1522	155.8	6.7	0.574	0.011
16	M	75	172.8	7.9	—	—	—	759	172.5	6.7	—	0.363
	F	65	161.5	5.3	—	—	—	673	161.4	6.2	—	0.455
17	M	44	176.6	7.1	—	—	—	617	173.9	6.8	—	0.007
	F	88	162.2	5.7	—	—	—	344	161.8	6.4	—	0.298

[1] M, mean; SD, standard deviation; P is for 2-tailed t-test; stature is in centimeters.

before the 1922 survey. The results of statistical comparison between the 1992 Victorian and 1970 NSW surveys (Table 2) show that this trend has apparently stabilized over the last two decades in 17-year-old females ($p = 0.298$), but may still be continuing (though at a slower rate) in their male counterparts ($p = 0.007$).

TABLE 3. Summary statistics and results of comparison of mean weight at ages 10–13 yr and 16–17 yr between the present "VIC 1992" sample, and "AUS 1985" and "NSW 1970" samples of males (M) and females (F)[1]

Age		VIC 1992			AUS 1985			NSW 1970			Difference (P) VIC 1992	
in years	Sex	N	M	SD	N	M	SD	N	M	SD	AUS 1985	NSW 1970
10	M	59	37.8	8.1	492	34.3	5.6	813	33.9	6.8	0.000	0.000
	F	77	38.1	9.1	497	34.8	6.6	636	33.8	6.8	0.000	0.000
11	M	45	41.1	10.3	487	38.9	7.8	807	37.2	7.2	0.040	0.000
	F	99	42.6	9.5	484	39.7	8.3	688	39.0	8.6	0.001	0.000
12	M	53	44.6	10.4	494	42.9	9.4	1411	41.6	7.8	0.112	0.004
	F	83	49.5	10.9	489	44.2	8.5	1534	43.4	8.7	0.000	0.000
13	M	69	54.5	12.8	466	49.1	10.2	1322	46.2	9.4	0.000	0.000
	F	83	52.1	9.0	437	49.6	8.5	1522	47.9	8.9	0.009	0.000
16	M	75	66.2	14.2	—	—	—	759	61.9	8.9	—	0.000
	F	65	60.3	11.9	—	—	—	673	55.1	7.9	—	0.000
17	M	44	67.8	7.6	—	—	—	617	64.9	9.7	—	0.026
	F	88	59.9	8.6	—	—	—	344	55.3	7.5	—	0.000

[1] M, mean; SD, standard deviation; P is for 2-tailed t-test; weight is in kilograms.

The secular increase in stature for peripubertal subjects showed, for both boys and girls, a rapid acceleration during the first five decades of this century, with evident stabilization of the increase after the 1954 NSW survey. Comparison of the total average gain in stature per decade over the last century between adults and peripubertal subjects confirms the general impression from viewing of the graphs in Figure 3. While the total average gain is only slightly higher for 12-year-old (1.3 cm/decade) than for 17-year-old males (1.2 cm/decade), it is much greater for 11-year-old (1.4 cm/ decade) than for 17-year-old females (0.5 cm/ decade). The observed difference in gain in stature between peripubertal and adult subjects represents shortening of the growth period, which was apparent until 1954. This phenomenon was, however, much more striking, and started earlier in history, for girls than for boys.

The results of comparisons between age-specific means for stature in boys and girls from the present sample, and from the two earlier samples (Table 2) confirm the overall trend shown in Figures 1 and 3. Thus, there is no change in the age specific means for stature between the present (VIC1992) and the AUS1985 samples (except for the marginally significant differences for 10-year-old boys and girls which may indicate some on-going trend toward a shortening of the growth period). Secular increase in stature is more apparent, especially in girls, if the means for stature are compared over the 22 year period between the present and the NSW1970 samples, where significant differences concern 10-, 13-, and 17-year-old boys, and 10- and 13-year-old girls.

Unlike stature, secular increase in weight is still continuing in both sexes, with rapid acceleration during the period between 1970 NSW and 1992 Victorian surveys. This is evident especially in 17-year-old females (Fig. 4), where two large increases (2.3 and 2.1 kg/decade) took place between 1908 and 1922, and between 1970 and 1992, respectively. However, the total average increase in adult weight was similar for males (1.2 kg/decade) and females (1.1 kg/decade). Secular trend in tempo of growth in weight is illustrated by the curves for 12-year-old boys and 11-year-old girls (Fig. 4). The pattern repeats that for the 17-year-old males and females, but with a much greater increase per decade during the last 20 years than in any earlier historical period considered in this study. The total average gain for both peripubertal boys and girls was only slightly higher than for 17-year-old counterparts (1.4 kg/decade compared with 1.2 kg/ decade, respectively).

The data in Figure 4 are supported by the results of comparisons between mean weights from the present and the two earlier studies. The data (Table 3) show that, except for 12-year-old boys, all age-specific means from the present sample (VIC1992) are significantly higher than those from either NSW1970 or AUS1985 samples, with greater differences between female than male samples.

Effect of socioeconomic status

The regression of weight on age (with sexes combined) did not vary between the three socioeconomic groups ($F_{20,1779} = 1.446$, $p = 0.09$), but the effect of socioeconomic status on stature was significant, with $F_{20,1797} = 3.24$ ($p < 0.0001$). However, for the sexes considered separately, the effect on stature was significant in males ($F_{10,831} = 4.624$, $p < 0.001$) but not in females ($F_{10,946} = 1.6$, $p = 0.1$). A plot of the differences between the mean curves for the three socioeconomic classes (data not shown) revealed that the gap between the upper and lower socio-economic classes in males consistently exceeded 1 cm, steadily increasing after age 11 and peaking at 4 cm in 16-year-old boys.

DISCUSSION

The interpretation of the results based on historical data is complicated, and especially so in Australia where the data from the successive surveys may have been affected by a diversity between individual states. This diversity is likely to be caused by differences in population structure, economic conditions, living standards, and influx of various immigrant groups at the time of respective surveys. Moreover, historical surveys varied with respect to sampling method and age categorization and, apart from the two latest ones included in this study, often did not report the sample sizes, standard deviations, or data collection procedures, essential for conducting and interpretation of statistical comparisons. In spite of these drawbacks, however, the data presented here show a distinct secular increase in growth in body height and weight spanning this century. This trend is consistent if comparisons are made separately for Victoria, New South Wales, and Western Australia (data not shown). This increase coincided with progressive improvement of socioeconomic and sanitary conditions, communication, and life standards in all states (former colonies) since 1901, when Australia became one nation (Shaw, 1970). The economic growth and prosperity reached its peak around 1950. An observed increase in stature per decade during this period is consistent with concurrent figures reported for Western European countries, Japan, and North America (Roche, 1979; Hauspie et al., 1997).

It has commonly been understood that secular changes in growth result from the combined effect of changes in overall body size at all ages, and changes in the period of time needed for the completion of growth (Hauspie et al., 1997). If the largest gain in height or weight over the period examined occurs around pubertal age, this reflects earlier puberty and thus shortening of the growth period. This gain alone does not affect final size and hence does not contribute to the secular trend in adult stature. The observed sharp increase in stature in peripubertal boys and girls, which took place especially between 1922 and 1954 surveys, indicates a shift toward an earlier onset of puberty, and thus increased tempo of growth (Tanner, 1966; Hauspie, 1979). As should be expected, the observed secular trend in tempo of growth in stature corresponded to a decrease in the age of menarche during the 1932–1972 period (reviewed in Harper and Collins, 1972). Both trends also coincided with the period of major improvement of socioeconomic conditions in this country (Shaw, 1970). After this period, the increase stabilized, consistent with the pattern of secular trend for the 17-year-old subjects. Indeed, comparison of menarcheal age estimated in the present 1992 study (12.8 years) and in the 1972 study of Harper and Collins (12.7 years) shows that pubertal age in white Australians has stabilized during the last two decades, concurrently with stabilization of growth increase.

It has been argued that the diminishing secular increase in the developed countries indicates that adult stature has almost reached a plateau implicated by genetic constrains (Hauspie et al., 1997). In this study, the cessation of secular trend in stature in 17-year-old females may well reflect the above phenomenon. While some continuing increase in 17-year-old males (the oldest subjects available to us at schools) may be related to the fact that these subjects have not yet completed their growth, and thus

have not reached a final stature (Chandler and Bock, 1991).

Apart from possible genetic constraints, slowing down of secular trend in stature reported in this study might have been caused by wider diversification of standards of living between various social groups starting around 1960, combined with a setback to economic growth due to severe drought in 1965/1966 (Shaw, 1970). Our data provided evidence for the effect of socioeconomic status on stature in male but not in female cross-sectional samples. It is also possible that the great influx of predominantly southern European migrants in the late 1950s (Price, 1981) has contributed to lowering the average stature in subsequent generations (children with both parents of southern European descent constituted approximately 15% of the present sample). Possible bias due to selective inclusion of lower socioeconomic classes has been accounted for by stratification of a sample according to the socioeconomic indicators.

A pattern of secular trend in adolescent weight in the present study shows a sharp increase between 1913 and 1954. However, unlike the pattern for stature, a secular trend of increase in both in adult and adolescent weight still continues. Present data is consistent with the results from two more recent Australian surveys of Victorian (Walkley et al., 1996) and New South Wales (Wilcken et al., 1996) schoolchildren. Furthermore, a similar trend in adults and children over the last few decades has been reported in other developed countries, and it has been mainly attributed to a decreasing energy expenditure combined with increasing energy intake (Eveleth and Tanner, 1990; Chung et al., 1992; Kuczmarski et al., 1994; Hill et al., 1996; Walkley et al., 1996). The lack of significant relationship between the socioeconomic status and weight in our sample has merely shown that the secular increase in weight cannot be reproduced among the SES groups.

Additional difficulty in understanding the recent secular changes in body weight are related to a controversy as to whether this trend can be interpreted as changes in body fatness. Firstly, evidence for the relationship between these two measures is inadequate (Himes, 1979). Secondly, no direct measurements of either subcutaneous fat or total body fatness have been conducted in the present sample. However, the relevant measure that was available in the present sample (body mass index, BMI), also showed a significant increase over the last two decades (Hill et al., 1996). Furthermore, the fact that secular increase in weight has occurred mainly in the category of obese subjects suggests that this increase can be largely attributed to excess of adipose tissue. Direct evidence has been provided by the earlier data obtained from Queensland schoolchildren, where secular changes in height, weight, and BMI were compared with changes in total body fatness. The results showed that, in girls, increase in these measures coincided with increase in body fatness, particularly since 1950 (Dugdale et al., 1983). However, this problem requires further studies where weight, body composition, and fatness are compared with fat availability in large samples of males and females.

CONCLUSIONS

The comparison of the results of our 1992 survey in Melbourne schools with historical data on body height and weight for white Australians spanning this century has demonstrated secular trend in both these measures. The greatest secular increase occurred in the first half of this century, corresponding to the decrease in pubertal age, and coinciding with the increase in economic prosperity of the nation. The data also shows that, while secular trend in body height has diminished during the last two decades, the trend of increasing body weight disproportionate to stature still continues at all ages, but especially for adolescent boys and girls. These findings warrant caution in the interpretation of the currently available growth standards for Australian children and adolescents (Australian Department of Health and NHMRC Growth Charts, 1975; Department of Endocrinology, Adelaide's Children Hospital Growth Charts, 1993). On the other hand, increasing trends in overweight for adolescent and adult males and females consistent with a number of other study data are alarming, and imply

the increased likelihood later in life of adverse health outcomes (report of National Research Council, US, 1989). In order to implement preventative measures, it is strongly recommended that factors determining these trends in the present generation of adolescents and young adults in developed countries be identified.

ACKNOWLEDGMENTS

The data presented were collected while D.Z. Loesch was receiving a NHMRC Senior Research Fellowship. The paper was completed when D.Z. Loesch and R.M. Huggins were receiving NICHD (US) grant #HD36071. The authors thank all the school children, teachers, and principals involved in the 1992 study of Melbourne schools for their support and participation.

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